Simulated Component Testing of Composite Helicopter Rotors

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This paper discusses the development of probabilistic methods –based software for predicting the fatigue reliability of composite structures. The material and geometric properties of composites and applied loads typically have significant variability. Variability can come from manufacturing methods, raw material batches, environmental or use conditions, or other sources. Traditional design methods normally relay on prototype or full-scale testing for variability analysis and/or reliability prediction. However, testing is often performed long after important decisions have already been made. Additionally, testing is both time consuming and costly.

The simulation software developed combines finite element analysis, fatigue failure modeling and first order reliability analysis methods. The methodology was demonstrated through analysis of composite helicopter rotor hub test specimen.

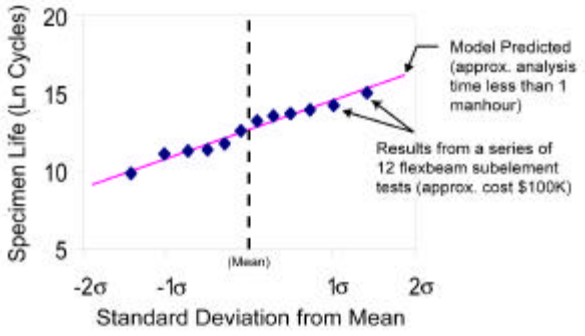

Figure 1: Software reliability predictions compared to component test data

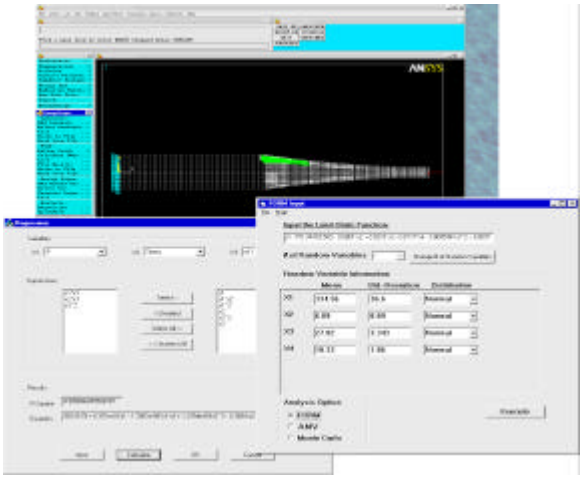

Figure 2: Variability Prediction Software

Software validation was achieved by comparing reliability predictions against actual component test data. This is shown in Figure 1. According to the component manufacturer, almost $1 million worth of prototype or full-scale testing typically would be required to certify this type of aerospace component. Although the developed simulation software will not totally eliminate the need for testing, it can be used to better focus test requirements. In this case, it is projected that simulation could reduce test costs by as much as 33 percent and significantly expedite component development.

The software (Figure 2) is fully integrated within the ANSYS finite element code. Currently the software is being Beta-tested under an ongoing Army contract.